An Internal Dose Assessment Associated with Personal Food Intake

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1. Introduction

In order to protect the population from radiation around a nuclear power plant, operators must evaluate the radiation dose of the residents. Individuals that are subject to public exposure have different habits, lifestyles, and personal characteristics.

ICRP (International Commission on Radiological Protection), Therefore, had recommended the concept of 'Critical Group'[1]. Recently the ICRP has recommended the use of 'Representative Person' on the new basic recommendation 103[2]. On the other hand the U.S. NRC (Nuclear Regulatory Commission) has adopted more conservative concept, 'Maximum Exposed Individuals (MEI)' of critical Group[3].

The dose assessment in Korea is based on MEI. Although dose assessment based on MEI is easy to receive the permission of the regulatory authority, it is not efficient. Meanwhile, the internal dose by food consumption takes an important part. Therefore, in this study, the internal dose assessment was performed in accordance with ICRP's new recommendations.

2. Methods and Results

2.1 Representative person

'Representative Person' on the new basic recommendation 103 is selected to represent highly exposed person in the population group who has reasonable, sustainable, and homogeneous habits.

On the other hand, MEI which has been adopted by U.S. NRC is more conservative. MEI of critical group means the single individual with the highest exposure in a given population. For example, personal food intake of representative person is found by calculating 95% percentile of the total population's food intake. On the other hand, personal food intake of MEI is obtained by summing 95% percentile of each food groups.

2.2 An Internal Dose Assessment with Food Intakes

The internal dose related in food consumption mostly accounts for radiological dose of public around NPPs. In Korea, dose related in the ingestion route accounts for more than 50% of dose from gaseous emissions. Furthermore, dose due to the intake of marine products accounts for more than 99.5% of dose from liquid effluent[4].

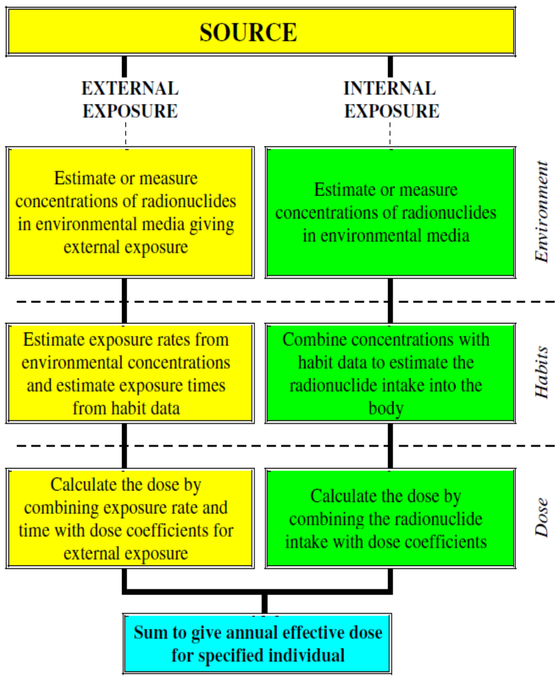

Fig. 1. Overview of dose assessment process

Radiation dose due to the ingestion of food is calculated by multiplying the dose conversion factor, radionuclide concentrations and food intake. Therefore, the internal consumption is directly proportional to the dose due to food intake.

2.3 The Top-Two Method

For deriving the food consumption, the dose calculation methods in 7 countries (U.S., Germany, Japan, Canada, France, U.K. and Korea) were investigated[5].

The British method which is named 'Top-two method' gives a high value of 97.5% for the two kinds of major food and others at the average food intake. This method was determined that the most efficient among methods which have been adopted by many countries.

Table Ⅰ. Examples of choosing representative person for food intake

Countries	Method of choosing representative person
USA	the maximum food intake (MEI)
Germany	
Korea	
Canada	The average food intake
Japan	
France	Different method according to the facility (ex. La Hague : the average food intake)
U.K.	Top-Two Method The top 2 foods : to use maximum food intake(97.5) The others : the average food intake

2.4 The Calculation of personal food intake

Table Ⅱ shows individual daily food intakes for average and MEI. It was calculated by multiplying the weighting factor and the gap between mean and 95 percentile of intake. The equation is represented below[6].

$$Max_i = G_{i,mean} + (T_{95} - T_{mean}) * w_i \quad (1)$$

T_{95} : 95 percentile of total intake
T_{mean} : mean of total intake
$G_{i,mean}$: mean of i^{th} food group's intake
w_i : weighting factor

TableⅡ. Individual daily food intakes except aquatic food (g/day)

	Average	MEI
Grain	291.9	439.1
Kimchi	145.9	246.2
Vegetable	222.8	443.3
Fruit	87.5	265.8
Milk	42.5	200.5
Beef	20.5	43.1
Pork	36.7	79.0
Chicken	38.5	78.4
TOTAL	886.3	1795.4

It is assumed that the intake distributions follow the normal distribution. Since dose assessment would be performed only for gaseous effluents, aquatic foods are excluded.

The 97.5 percentile food intakes of grain and vegetable which take first and second place in food groups were obtained.

Table Ⅲ. Individual daily intakes of top two groups (g/day)

	Average	MEI	97.5 percentile
Grain	291.9	439.1	465.7
Vegetable	222.8	443.3	483.1

Total intake calculated using the top two methods was 1,320.5g/day. Compared with MEI, this value is 26% less.

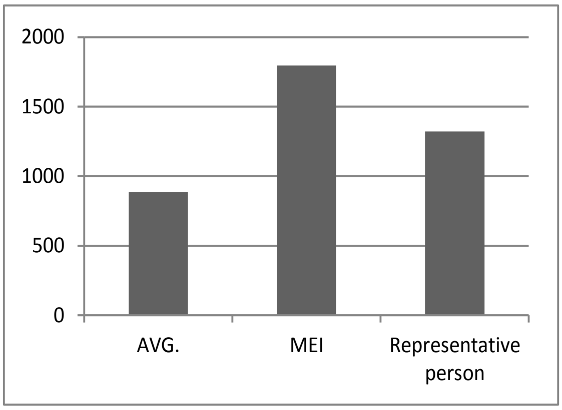

Fig. 2. Individual daily food intake except aquatic food (g/day)

2.5 Internal Dose Assessment

A Calculation of annual internal dose due to gaseous effluents using the concepts of MEI and representative person with top-two method was performed. An annual internal dose due to gaseous effluent was 4.212μSv/yr for MEI and 3.655μSv/yr for representative person. Compared to each other, the result for representative person was 13.2% less than for MEI.

Table Ⅳ. An annual internal dose due to gaseous effluents (μSv/yr)

MEI	Representative person using top-two method
291.9	439.1
222.8	443.3

3. Conclusions

The internal dose assessment was performed in accordance with ICRP's new recommendations. It showed 13.2% decreased of the annual internal dose due to gaseous effluents by replacing MEI to the concept of representative person. Also, this calculation based on new ICRP's recommendation has to be extended to all areas of individual dose assessment. Then, more accurate and efficient values might be obtained for dose assessment.

The information of the dose obtained in this study might contribute to being used for the basic tool of the optimization of radiation protection.

Acknowledgement

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